

PESTICIDE RESIDUES IN SOILS

R.B. McKercher

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Saskatchewan Crop Production in Relation to Pollution

The heading on your program brochure would seem to allow me vast scope. If, however, I took this liberty I am sure that my attempts would quickly be found to be a masquerade. I, therefore, shall restrict my remarks to those of direct concern to the herbicide and insecticide situation we are researching on Saskatchewan soils.

I hope that you do not misunderstand the research efforts in Saskatchewan. We are actively conducting research at the University, both in Soil Science under my direction and in Crop Science on herbicides under Dr. Ross Ashford. On campus also is Canada Agriculture Research Station where Dr. Jadu Saha has a research group interested in insecticides. At Regina, the C.D.A. also has an active and productive group working on herbicide research under Dr. Jim Hay's direction. This brief catalog refers only to those whose research has direct or implied reference to soil. There are other studies or monitorings proceeding at both the University, Federal, Provincial and Municipal levels which could provide data of interest on herbicides and insecticides with respect to their agricultural implications.

I should at this time say in addition that this is not the first attempt at gathering information of this nature. Most of you will know that the A.I.C. consigned an edition of its journal to related topics of pollution. Near the same time, the Western Section of the National Soil Survey Committee devoted a day of its deliberations to a topic very similar to the one I have today. At about this time, also, Dr. H.J. Atkinson in Ottawa was the editor-convenor of a national report which was never publicly released. More recently, the Saskatchewan Institute of Agrologists obtained reports on the Saskatchewan situations from various

people and Dr. Doug Knott ably organized and edited the final report just released.

On the face of it, all these efforts have been staged as if by the same director. All the initiating ideas were greeted with great enthusiasm of anticipation for the probable offerings, except by the participants. All initially were thought of as likely to produce a lot more data and quite a few more answers than they finally were able to. All took longer than originally dreamt of to produce. All to my judgement were failures with respect to their impact and use as public offerings. Yet they all to a most worthwhile extent provided impetus, if not sources of adequate funding, to further the work of those interested in research. On this latter point, that of research guidance, these previous efforts were truly valuable.

This brings me to a point where I better start justifying use of this time. Firstly, what do we have for data in Saskatchewan? There are two published papers relating to residues in agricultural soils (1,2). Both concern mainly chlorinated hydrocarbons which happen to be the most persistent of chemicals in soils as in other parts of the environment. For the most part levels of dieldrin, aldrin, endrin, heptachlor and chlordane, all insecticides, were in a range from about 20 ppb down to undetectable amounts. These levels are quite low. DDT and its analogues were present only where large rates of application were known to occur. The herbicide triallate appeared to be persistent under our conditions since it was present in all three of the soils tested but at levels of less than about 1 ppm.

Herbicides are used on much greater acreages than insecticides. They are however, the lesser problem from the residue aspect. There are reasons for this. Herbicides are generally less difficult chemicals to degrade by all the methods through which organic chemicals degrade. Herbicide usage in the past has probably received somewhat better supervision by such watchful bodies as the Canada Weed Committee. The newer chemicals which are being developed and which may be more recalcitrant are under much more careful registration and use regulations than in the past.

One of the major problems we have with pesticides in the soil science field is assessing what soil residue levels mean as hazards. Tolerance levels have never been established for soils and are not likely to be because no elucidation of what portion of a residue will be removed by a plant has been made. It is known that different vegetables remove different amounts, that cereals take out far less than legumes and alfalfa, and that the residues accumulate in different tissue within any given plant species. In the final analysis, what enters the food train is important but for soil residues it would be useful if one knew before hand, from soil characteristics, the probable plant uptake. This might not be so easily established for the soil and climate variability we suffer.

At this time it is in order to tell you something of our research. This research to date has been wholly conducted through graduate students. There are advantages in such operation of research, mainly that one has always an input of fresh, novel ideas and hence a variety of programs emerge as will soon be apparent. The major disadvantage is that projects must be of a nature so they can be terminated after relatively short times. Seldom do new students fancy the projects of their predecessors and funding has always been of a temporary nature at the University level.

The first published research out of our lab came from Dr. R.J. Hance (3). He determined that our dominant clays, the montmorillonitic types, could under certain conditions absorb significant quantities of herbicides. At this same time both Keith Head (2) and Dr. Saha (1) were attempting to estimate residue levels already referred to. Considerable work on analytical methods was required for both their projects.

Dr. Jim Moyer (4) has recently completed the major work of our laboratory to date. He conducted a rather exhaustive study of the interaction of the soil colloids with herbicide chemicals, the effect of adsorption on herbicide breakdown, and the availability of adsorbed herbicide to plants. He has one report now in press in Soil Biology and Biochemistry, another submitted to

the Canadian Journal of Plant Science and has a third manuscript in preparation.

More recent efforts have been to study the degradation patterns of the phenoxy acetic acids in soil and to determine the possible relationship that stereoisomerism may have with respect to phytotoxicity and soil persistence. Kerry Foster has found that the patterns of 2,4-D, MCPA and 2,4,5-T degradation vary from soil to soil (Figure 1), that the half-lives of the chemicals differ considerably from soil to soil and are influenced by moisture levels and that the degradation is firstly an etherase cleavage (see Figure 2) and hence is microbiological in nature.

Bob Morgan will be attempting to synthesize and study reactivities of the cis- and trans- isomers (Figure 3) of S-2,3-dichloro-allyl,N,N-diisopropylthiol carbamate, commonly called diallate or Avadex. This material is commercially available as a mixture of the isomers but it is possible that advantages may be found in higher toxicity or less persistence of one or another of these isomers.

In summary, our work has as its final objective to provide information useful in the practical sense but the route to these answers may not be clear from a given project. We are attempting to determine the function of all factors of soil and chemical which influence behavior of the chemical once it contacts the soil until its harmless disappearance. This involves a complete assessment of the products of degradation, their chemistry, reactions in the soil, toxicity to life forms and any inference to root, nutrient exchange and microbiological systems in the soil during their times of residence.

References

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2. Head, W.K. and R.B. McKercher. Can. J. Soil Sci. 51, 423-430 (1971).
3. Hance, R.J. Can. J. Soil Sci. 49, 357-364 (1969).
4. Moyer, J.R. Ph.D. thesis, Univ. of Sask. (1971).

Abstract

Data available on Saskatchewan soils for herbicide and insecticide residue levels is referred to. Implications of soil residues are briefly mentioned. The research of the laboratories in the Dept. of Soil Science is discussed in summary form.

Figure 1. Rates of 2,4-D acid disappearance from soils.

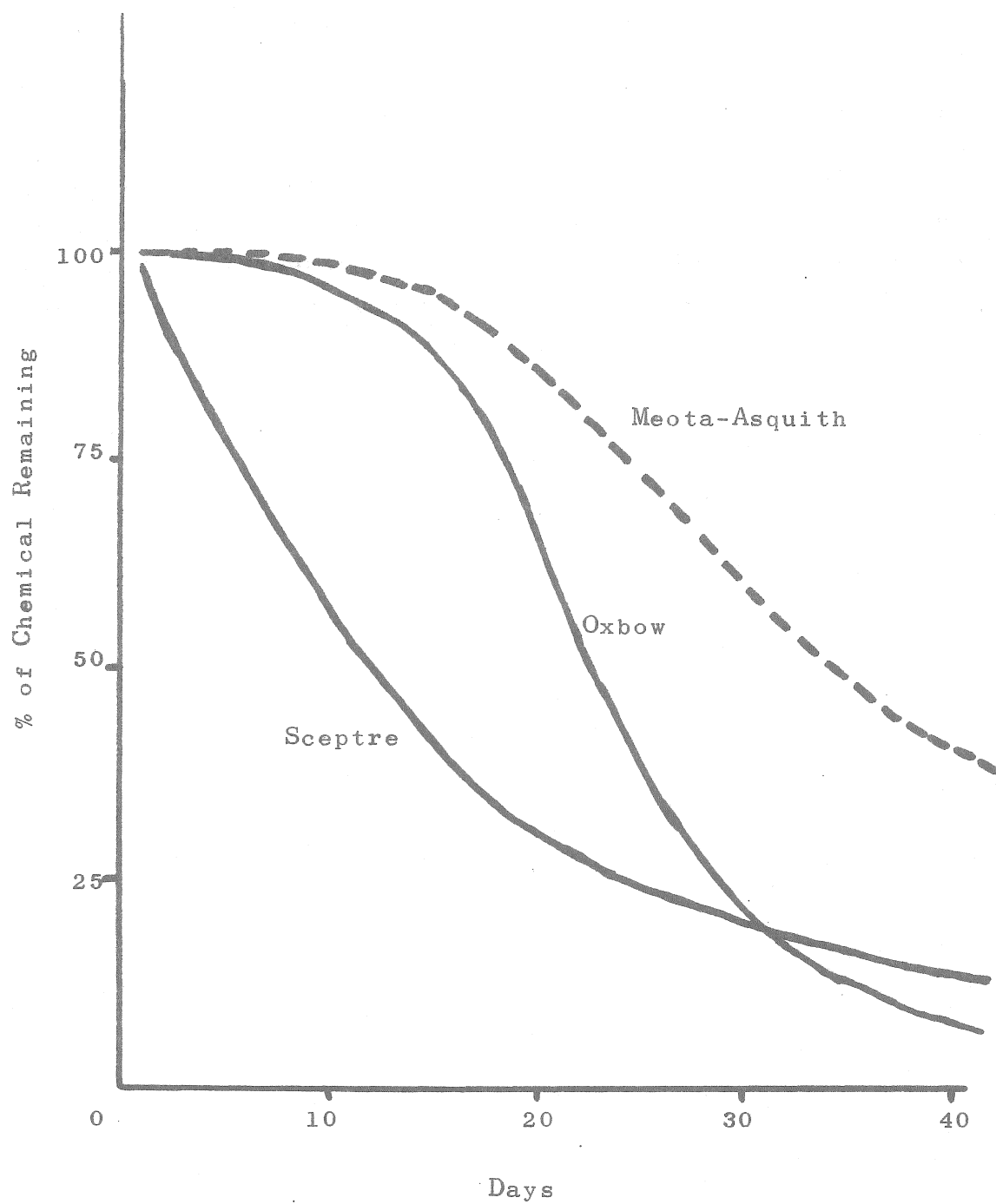
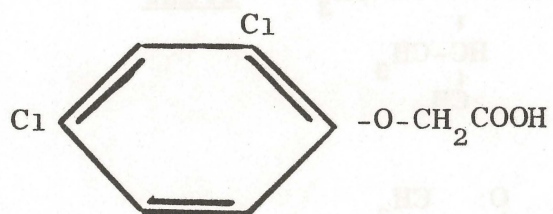
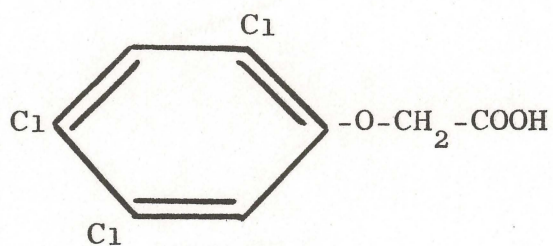


Figure 2. Structures of 2,4-D, 2,4,5-T and MCPA

2,4-D



2,4,5-T



MCPA

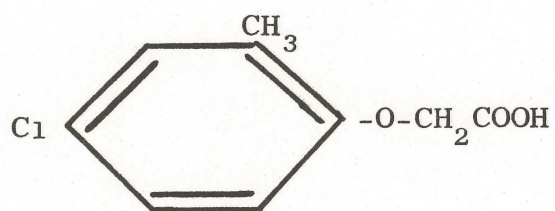


Figure 3. Stereoisomers of diallate (Avadex)

DIALLATE

